IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

APPEAL BRIEF FOR THE APPELLANT

Ex parte OHMI et al.

PLASMA PROCESSING APPARATUS AND PLASMA PROCESSING METHOD

Application No.: 09/864,376
Filed: May 25, 2001
Appeal No.: *Not Yet Assigned*
Group Art Unit: 1763
Examiner: Rudy ZERVIGON

Responsive to the Office Communication mailed March 19, 2009 and further to the Notice of Appeal filed on July 11, 2007, submitted herewith is a Supplemental Appeal Brief. Please charge any fee deficiencies required with respect to this paper, or credit any overpayment to our Deposit Account No. 01-2300, referencing Attorney Docket Number **107176-00007**.

Respectfully submitted,

ARENT FOX LLP

Sheree Rowe
Attorney for the Appellant
Registration No. 59,068

Customer No.: 004372
ARENT FOX LLP
1050 Connecticut Avenue, NW, Suite 400
Washington, DC 20036-5339
Telephone: 202-857-6000
Fax: 202-857-6395
Date: March 27, 2009

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## THE HONORABLE BOARD OF PATENT APPEALS AND INTERFERENCES

In re the application of:

OHMI et al.

Group Art Unit: 1763

Application No.: 09/864,376

Examiner: Rudy ZERVIGON

Filed: May 25, 2001

Attorney Docket No.: 107176-00007

For: PLASMA PROCESSING APPARATUS AND PLASMA PROCESSING METHOD

## SUPPLEMENTAL BRIEF ON APPEAL

Attorney for the Appellant:
Sheree Rowe
Arent Fox LLP
1050 Connecticut Avenue, NW
Suite 400
Washington, DC 20036-5339

Telephone: 202-857-6000
Fax: 202-857-6395

Customer No.: **004372**
Date: April 1, 2009

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# I. INTRODUCTION

This Supplemental Appeal Brief is responsive to the Office Communication mailed March 19, 2009 and is an appeal from the action of the Examiner dated January 11, 2007, finally rejecting claims 1-9, 12-14, and 16-26, as being unpatentable over certain prior art under 35 U.S.C. § 103. A Notice of Appeal was timely filed on July 11, 2007 with a request for a Pre-Appeal Review. On August 3, 2007, a Notice of Panel Decision From Pre-Appeal Review was issued continuing the rejection of claims 1-9, 12-14, and 16-26.

# II. REAL PARTY IN INTEREST

The real party in interest in the present application is Rohm Co., Ltd., a corporation of Kyoto, Japan and Tadahiro Ohmi, an individual of Miyagi, Sendai, Japan, the assignees of record.

# III. RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences known to the Applicants or Appellants' representative which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

# IV. STATUS OF CLAIMS

Claims 1-9, 12-14, and 16-26 are pending. Claims 10-11 and 15 were previously canceled. Claims 1-9, 12-14, and 16-26 are rejected. Claims 1-9, 12-14, and 16-26 are being appealed.

## V. STATUS OF AMENDMENTS

All amendments have been entered prior to filing the instant appeal brief.

## VI. SUMMARY OF THE CLAIMED SUBJECT MATTER

The claimed invention relates to a plasma processing apparatus for processing an object using a plasma and a plasma processing method for processing an object using a plasma.

### A. Independent Claim 1

An embodiment of a plasma processing apparatus for processing an object using a plasma, as recited in independent claim 1 and dependent claims 3, 5-6, and 9, which depend from claim 1, is illustrated in Figure 1 and includes a processing chamber (1, in Fig. 1) defining a processing cavity (3, in Fig. 1) for containing an object (W, in Fig. 1) to be processed and a process gas (PROCESS GAS, in Fig. 1) therein; a microwave radiating antenna (6, in Fig. 1) having a microwave radiating surface for radiating a microwave in order to excite a plasma in the processing cavity (3, in Fig. 1); and a dielectric body (2, in Fig. 1) provided so as to be opposed to the microwave radiating surface. See also the description on page 7, line 20 – page 8, line 18.

Figure 1 shows that there is no additional microwave radiating antenna placed between the microwave radiating antenna (6) and the dielectric body (2). See Figure 1.

The plasma processing apparatus of claims 1 includes a distance D (illustrated as d1+d2 in Fig. 1) between the microwave radiating surface (6) and a surface of the dielectric body (2) facing away from the microwave radiating surface which, which is represented with a wavelength of the microwave being a distance unit, wherein the distance is determined to be in a range satisfying an inequality $0.7 \times n/4 \leq D \leq 1.3 \times n/4$

(n being a natural number); whereby a standing wave of the microwave is formed between the microwave radiating surface (6) and a plasma exciting surface , thereby exciting a plasma at the plasma exciting surface by being supplied with energy from the standing wave of the microwave, the plasma exciting surface substantially coinciding with the surface of the dielectric body (2) facing away from the microwave radiating surface (6), the plasma being formed between the plasma exciting surface and the object to be processed (W), the standing wave not entering the plasma, wherein one end of the standing wave is positioned on the plasma exciting surface. See page 18, line 15 – page 19, line 23.

B. Independent Claim 2

An embodiment of a plasma processing apparatus for processing an object using a plasma, as recited in independent claim 2 and dependent claim 4, which depends from claim 2, is illustrated in Figure 1 and includes a processing chamber (1, in Fig. 1) defining a processing cavity (3, in Fig. 1) for containing an object (W, in Fig. 1) to be processed and a process gas (PROCESS GAS, in Fig. 1) therein; a microwave radiating antenna (6, in Fig. 1) having a microwave radiating surface for radiating a microwave in order to excite a plasma in the processing cavity (3, in Fig. 1); and a dielectric body (2, in Fig. 1) provided so as to be opposed to the microwave radiating surface. See also the description on page 7, line 20 – page 8, line 18.

Figure 1 shows that there is no additional microwave radiating antenna placed between the microwave radiating antenna (6) and the dielectric body (2). See Figure 1.

The plasma processing apparatus of claim 2 includes a distance D (illustrated as d1+d2 in Fig. 1) between the microwave radiating surface (6) and a surface of the dielectric body (2) facing away from the microwave radiating surface which, which is

represented with a wavelength of the microwave being a distance unit, the distance determined to be in a range satisfying an inequality $0.7 \times n/2 \leq D \leq 1.3 \times n/2$ (n being a natural number); whereby a standing wave of the microwave is formed between the microwave radiating surface (6) and a plasma exciting surface, thereby exciting a plasma at the plasma exciting surface by being supplied with energy from the standing wave of the microwave, the plasma exciting surface substantially coinciding with the surface of the dielectric body (2) facing away from the microwave radiating surface (6), the plasma being formed between the plasma exciting surface and the object to be processed (W), the standing wave not entering the plasma, wherein one end of the standing wave is positioned on the plasma exciting surface. See page 18, line 15 – page 19, line 23.

C. Independent claim 7

Page 9, lines 11-24 describes a plasma processing method for processing an object using a plasma, as recited in independent claim 7 and dependent claims 12, 13, and 14, which depend from claim 7, the method comprising the steps of putting an object to be processed (W) and a process gas into a processing cavity (3) (Figure 1) defined in a processing chamber (1); radiating a microwave for exciting a plasma from a microwave radiating antenna (6) having a microwave radiating surface to the processing cavity (3); and providing a dielectric body (2) so as to be opposed to the microwave radiating surface.

Page 18, line 15 – page 19, line 23 describes the step of determining a distance D (shown as d1 +d2 in Figure 1) between the microwave radiating surface (6) and a surface of the dielectric body (2) facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, wherein

the distance is determined to be in a range satisfying an inequality $0.7 \times n/4 \leq D \leq 1.3 \times n/4$ (n being a natural number); whereby a standing wave of the microwave is formed between the microwave radiating surface (6) and a plasma exciting surface, thereby exciting a plasma at the plasma exciting surface by being supplied with energy from the standing wave of the microwave, the plasma exciting surface substantially coinciding with the surface of the dielectric body (2) facing away from the microwave radiating surface (6), the plasma being formed between the plasma exciting surface and the object to be processed (W), the standing wave not entering the plasma, wherein one end of the standing wave is positioned on the plasma exciting surface.

Figure 1 shows that there is no additional microwave radiating antenna placed between the microwave radiating antenna (6) and the dielectric body (2). See Figure 1.

D. Independent claim 8

Page 9, lines 11-24 describes a plasma processing method for processing an object using a plasma, as recited in independent claim 8, the method comprising the steps of putting an object to be processed (W) and a process gas into a processing cavity (3) (Figure 1) defined in a processing chamber (1); radiating a microwave for exciting a plasma from a microwave radiating antenna (6) having a microwave radiating surface to the processing cavity (3); and providing a dielectric body (2) so as to be opposed to the microwave radiating surface.

Page 18, line 15 – page 19, line 23 describes the step of determining a distance D (shown as d1 +d2 in Figure 1) between the microwave radiating surface (6) and a surface of the dielectric body (2) facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, wherein the distance is determined to be in a range satisfying an inequality $0.7 \times n/2 \leq D \leq 1.3 \times$

n/2 (n being a natural number); whereby a standing wave of the microwave is formed between the microwave radiating surface (6) and a plasma exciting surface, thereby exciting a plasma at the plasma exciting surface by being supplied with energy from the standing wave of the microwave, the plasma exciting surface substantially coinciding with the surface of the dielectric body (2) facing away from the microwave radiating surface (6), the plasma being formed between the plasma exciting surface and the object to be processed (W), the standing wave not entering the plasma, wherein one end of the standing wave is positioned on the plasma exciting surface.

Figure 1 shows that there is no additional microwave radiating antenna placed between the microwave radiating antenna (6) and the dielectric body (2). See Figure 1.

E. Independent Claim 16

An embodiment of a plasma processing apparatus for processing an object using a plasma, as recited in independent claim 16 and dependent claims 18, 19, 20, 21, and 22, which depend from claim 16, is illustrated in Figure 1 and includes a processing chamber (1, in Fig. 1) defining a processing cavity (3, in Fig. 1) for containing an object (W, in Fig. 1) to be processed and a process gas (PROCESS GAS, in Fig. 1) therein; a microwave radiating antenna (6, in Fig. 1) having a microwave radiating surface for radiating a microwave in order to excite a plasma in the processing cavity (3, in Fig. 1); the microwave antenna being a radial slot antenna having a number of slots formed and distributed in the microwave radiating surface (see Fig. 2 and page 8, lines 17-24), and a dielectric body (2, in Fig. 1) provided so as to be opposed to the microwave radiating surface. See also the description on page 7, line 20 – page 8, line 18.

Figure 1 shows that there is no additional microwave radiating antenna placed between the microwave radiating antenna (6) and the dielectric body (2). See Figure 1.

The plasma processing apparatus of claim 16 includes a distance D (illustrated as d1+d2 in Fig. 1) between the microwave radiating surface (6) and a surface of the dielectric body (2) facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, wherein the distance is determined to be in a range satisfying an inequality $0.7 \times n/4 \leq D \leq 1.3 \times n/4$ (n being a natural number), wherein one end of the standing wave is positioned on the plasma exciting surface. See page 18, line 15 – page 19, line 23.

F. Independent Claim 17

An embodiment of a plasma processing apparatus for processing an object using a plasma, as recited in independent claim 17 is illustrated in Figure 1 and includes a processing chamber (1, in Fig. 1) defining a processing cavity (3, in Fig. 1) for containing an object (W, in Fig. 1) to be processed and a process gas (PROCESS GAS, in Fig. 1) therein; a microwave radiating antenna (6, in Fig. 1) having a microwave radiating surface for radiating a microwave in order to excite a plasma in the processing cavity (3, in Fig. 1); the microwave antenna being a radial slot antenna having a number of slots formed and distributed in the microwave radiating surface (see Fig. 2 and page 8, lines 17-24), and a dielectric body (2, in Fig. 1) provided so as to be opposed to the microwave radiating surface. See also the description on page 7, line 20 – page 8, line 18.

Figure 1 shows that there is no additional microwave radiating antenna placed between the microwave radiating antenna (6) and the dielectric body (2). See Figure 1.

The plasma processing apparatus of claim 17 includes a distance D (illustrated as d1+d2 in Fig. 1) between the microwave radiating surface (6) and a surface of the dielectric body (2) facing away from the microwave radiating surface, which is

represented with a wavelength of the microwave being a distance unit, wherein the distance is determined to be in a range satisfying an inequality 0.7 x n/2 ≤ D ≤ 1.3 x n/2 (n being a natural number), wherein one end of the standing wave is positioned on the plasma exciting surface. See page 18, line 15 – page 19, line 23.

G. Independent Claim 23

Page 9, lines 11-24 describes a plasma processing method for processing an object using a plasma as recited in independent claim 23 and dependent claims 25 and 26, which depend from claim 23, the method comprising the steps of putting an object to be processed (W) and a process gas into a processing cavity (3) (Figure 1) defined in a processing chamber (1); radiating a microwave for exciting a plasma from a microwave radiating antenna (6) having a microwave radiating surface to the processing cavity (3), the microwave radiating antenna being a radial slot antenna having a number of slots formed and distributed in the microwave radiating surface (see Fig. 2 and page 8, lines 16-24); and providing a dielectric body (2) so as to be opposed to the microwave radiating surface.

Page 18, line 15 – page 19, line 23 describes the step of determining a distance D (shown as d1 +d2 in Figure 1) between the microwave radiating surface (6) and a surface of the dielectric body (2) facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, wherein the distance is determined to be in a range satisfying an inequality 0.7 x n/4 ≤ D ≤ 1.3 x n/4 (n being a natural number); wherein one end of the standing wave is positioned on the plasma exciting surface.

Figure 1 shows that there is no additional microwave radiating antenna placed between the microwave radiating antenna (6) and the dielectric body (2). See Figure 1.

H. Independent Claim 24

Page 9, lines 11-24 describes a plasma processing method for processing an object using a plasma as recited in claim 24, the method comprising the steps of putting an object to be processed (W) and a process gas into a processing cavity (3) (Figure 1) defined in a processing chamber (1); radiating a microwave for exciting a plasma from a microwave radiating antenna (6) having a microwave radiating surface to the processing cavity (3); and providing a dielectric body (2) so as to be opposed to the microwave radiating surface.

Page 18, line 15 – page 19, line 23 describes the step of determining a distance D (shown as d1 +d2 in Figure 1) between the microwave radiating surface (6) and a surface of the dielectric body (2) facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, wherein the distance is determined to be in a range satisfying an inequality $0.7 \times n/2 \leq D \leq 1.3 \times n/2$ (n being a natural number); wherein one end of the standing wave is positioned on the plasma exciting surface.

Figure 1 shows that there is no additional microwave radiating antenna placed between the microwave radiating antenna (6) and the dielectric body (2). See Figure 1.

I. Dependent Claims

Figure 1 shows a thickness d2 of the dielectric body. In claim 3 this thickness, d, is determined to be in a range satisfying an inequality $0.7 \times n/4 \leq d \leq 1.3 \times n/4$ (n being a natural number). See page 5, lines 12-23. In claim 4, this thickness, d, is determined to be in a range satisfying an inequality $0.7 \times n/2 \leq d \leq 1.3 \times n/2$ (n being a natural number). See page 5, line 24 - page 6, line 3.

Figure 2 shows an exemplary embodiment of the microwave radiating antenna (6) being a radial line slot antenna having a number of slots (S1, S2, . . .) formed and distributed in the microwave radiating surface thereof for radiating the microwave, as claimed in claims 5 and 12. See page 6, lines 3-7.

Figure 2 also shows the number of slots being concentrically arranged in the microwave radiating surface, as recited in claims 6, 9, 14, and 21. See page 8, lines 20-24. Page 14, line 17 – page 15, line 7, describes an embodiment wherein a number of slots, or one per six or three slots, in the peripheral direction of the slots arranged in the outermost peripheral part are closed so as to uniformize, in a plane, the plasma generated in the processing cavity, as recited in claims 6, 9, 13, 14, 20, 22, 25, and 26. See also page 6, lines 7-19.

Dependent claim 18 includes the dielectric body (2) being a plate shaped member disposed in such as manner that a distance between the dielectric plate (2) and the plasma radiating surface is substantially zero, and a thickness d of the dielectric plate (2) (shown as d2 in Figure 1) which is represented with the wavelength of the microwave being a distance unit, is determined to be in a range satisfying an inequality $0.7 \times n/4 \leq d \leq 1.3 \times n/4$ (n being a natural number). See page 18, line 15 – page 19, line 23.

Dependent claim 19 includes the dielectric body (2) being a plate shaped member disposed in such as manner that a distance between the dielectric plate (2) and the plasma radiating surface is substantially zero, and a thickness d of the dielectric plate (2) (shown as d2 in Figure 1) which is represented with the wavelength of the microwave being a distance unit, is determined to be in a range satisfying an inequality

$0.7 \times n/2 \leq d \leq 1.3 \times n/2$(n being a natural number). See page 18, line 15 – page 19, line 23.

## VII. GROUNDS OF REJECTION

Under 35 U.S.C. § 103(a), claims 1-5, 7, 8, 9, 12, and 13 are rejected as being unpatentable over Tokuda et al. (U.S. Patent No. 5,134,965, hereinafter "Tokuda") in view of Otsubo et al. (U.S. Patent No. 4,985,109, hereinafter "Otsubo"), and Ohmi et al. (U.S. Patent No. 6,830,652, hereinafter "Ohmi"); claim 6 as being unpatentable over Tokuda, Otsubo and Ohmni, in view of Tsuchihashi et al. (U.S. Patent No. 6,109,208, hereinafter "Tsuchihashi"); claim 14 as being unpatentable over Tokuda, Otsubo, and Ohmi in view of Tsuchihashi and further in view of Masaaki et al. (U.S. Patent No. 6,109,208, hereinafter "Masaaki"); and claims 16-26 as being unpatentable over Tokuda and Otsubo in view of Ohmi.

## VIII. APPELLANTS' ARGUMENTS

### A. Legal Overview

Thus, the U.S. Patent and Trademark Office ("PTO") bears the burden under 35 U.S.C. § 103 of establishing a *prima facie* case of obviousness. *In re Fine*, 5 U.S.P.Q.2d at 1598. If an Examiner fails to establish a *prima facie* case, the rejection is improper and will be overturned. *See In re Rijckaert*, 9 F.3d 1531 (Fed. Cir. 1993). "If examination....does not produce a *prima facie* case of unpatentability, then without more the applicant is entitled to the grant of the patent." *In re Oetiker*, 977 F.2d 1443, 1145 (Fed. Cir. 1992).

To establish *prima facie* obviousness of a claimed invention, all of the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981 (CCPA 1974).

Several basic factual inquiries must be made to determine obviousness or non-obviousness of patent application claims under 35 U.S.C. § 103. These factual inquiries are set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 17, 148 U.S.P.Q. 459, 467 (1966):

> Under § 103, the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; the level of ordinary skill in the pertinent art resolved. Against this backdrop, the obviousness or non-obviousness of the subject matter is determined.

The specific factual inquiries set forth in Graham have not been considered or properly applied by the Examiner formulating the rejections of the claims. Particularly, the differences between the prior art and the claims were not properly determined. As stated by the Federal Circuit in *In re Ochiai*, 37 U.S.P.Q. 2d 1127, 1131 (Fed. Cir. 1995):

> The test of obviousness *vel non* is statutory. It requires that one compare the claim's subject matter as a whole with a prior art to which the subject matter pertains. 35 U.S.C. § 103.
>
> The inquiry is *highly fact-specific by design*....When the references cited by the Examiner fail to establish a prima facie case of obviousness, the rejection is improper and will be overturned. *In re Fine*, 837 F.2d 1071, 1074, 5 U.S.P.Q. 2d 1596, 1598 (Fed. Cir. 1988). (Emphasis added.)

The Appellants respectfully submit that the Examiner has not made a proper *prima facie* rejection under 35 U.S.C. § 103(a), because the alleged combination fails to disclose or suggest at least one of the claim limitations in each of the pending claims.

B. The Cited Art Omits Essential Elements Needed for a Prima Facie Rejection

i. Claims 1, 2, 16, and 17

Claims 1 and 2 recite a plasma processing apparatus for processing an object using a plasma, comprising, among other features, a microwave radiating antenna having a microwave radiating surface and a dielectric body provided so as to be opposed to the microwave radiating surface, wherein **no additional microwave radiating antenna is placed between the microwave radiating antenna and the dielectric body**, and wherein a **distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, is determined to be in a range satisfying an inequality**, and wherein **one end of the standing wave is positioned on the plasma exciting surface**.

Claims 16 and 17 recite a plasma processing apparatus for processing an object using a plasma, comprising, among other features, a microwave radiating antenna having a microwave radiating surface, the microwave radiating antenna being a radial line slot antenna having a number of slots formed and distributed in the microwave radiating surface, a dielectric body provided so as to be opposed to the microwave radiating surface, wherein **no additional microwave radiating antenna is located between the microwave radiating antenna and the dielectric body**, and wherein **a distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating surface, which is**

**represented with a wavelength of the microwave being a distance unit, is determined to be in a range satisfying an inequality**, and wherein **one end of the standing wave is positioned on the plasma exciting surface**.

Tokuda teaches an arrangement with **two** slot antennas 32 and 34. One slot antenna 32 is in contact with the upper surface of a quartz plate 5, while the other slot antenna 34 is disposed above the slot antenna 32 with the distance t being provided between the two antennas that is set to be an integral multiple of half of the guide wavelength or a value near the integral multiple thereof. See Col. 14, lines 2-5. Thus, Tokuda merely teaches a distance between dual slot antennas, not a distance between an antenna closest to a dielectric body and the far surface of the dielectric body. Tokuda fails to mention a distance between the lower surface of the slot antenna 32 and the lower surface of the quartz plate 5, and there is no mention of the thickness of quartz plate 5.

The Applicants further note that the Office Action continues to cite 34 as the lower surface of the antenna and t as the distance D, even though claims 1, 2, 16, and 17 were amended to recite wherein no additional microwave radiating antenna is placed therebetween the microwave radiating antenna and the dielectric body. The distance between antenna 34 and quartz plate 5 includes intervening antenna 32, and distance t is the distance between antennas 32 and 34.

The Office Action cites Ohmi as allegedly teaching "In order to prevent the discharge, the thickness of the dielectric material shower plate 103 is determined so that the gap is located at a position of a node of the standing wave of the microwave electric field," (see Office Action, Page 4). However, the thickness of the shower plate

103 in Ohmi is determined only so that a node of the standing wave is positioned **within the gap 104 between the lower surface of the dielectric material separation wall 102 and the shower plate 103**, thereby preventing the discharge at the gap 104. See Col. 13, lines 8-12. There is no mention of the thickness of the dielectric material separation wall 102 of Ohmi, which allegedly corresponds to the dielectric body of the present invention.

Accordingly, even if combined with Tokuda (not admitted), Ohmi fails to contribute the missing relationship between the closest antenna and the far surface of the dielectric body of Tokuda.

Otsubo is cited as allegedly teaching a concentric slot antenna in a microwave plasma reactor having a number of slots formed and distributed in the microwave radiating surface where a part of the number of slots can be closed. Tsuchihashi is cited as allegedly teaching a similar microwave plasma generating device including plural slots in the peripheral direction of the shutter antenna. Neither Otsubo or Tsuchihashi, nor Masaaki cure the deficiencies of Tokuda and Ohmi as outlined above.

To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. M.P.E.P. § 2143.03. For at least this reason, the Applicants submit that claims 1, 2, 16, and 17 are allowable over the cited art. As claims 1, 2, 16, and 17 are allowable, the Applicants submit that claims 3-6 and 18-22, which depend from allowable claims 1, 2, 16, and 17, are therefore also allowable for at least this combination of reasons and for the additional subject matter recited therein.

ii. Claims 7, 8, 23, and 24

Claims 7 and 8 recite a plasma processing method for processing an object using a plasma, the method comprising the steps of, among others, radiating a microwave for exciting a plasma from a microwave radiating antenna having a microwave radiating surface to the processing cavity, providing a dielectric body so as to be opposed to the microwave radiating surface, and determining **a distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, to be in a range satisfying an inequality**, and wherein no **additional microwave radiating antenna is located between the microwave radiating antenna and the dielectric body**, and wherein **one end of the standing wave is positioned on the plasma exciting surface**.

Claims 23 and 24 recite a plasma processing method for processing an object using a plasma, the method comprising the steps of, among others, radiating a microwave for exciting a plasma from a microwave radiating antenna having a microwave radiating surface to the processing cavity, providing a dielectric body so as to be opposed to the microwave radiating surface, and determining **a distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, to be in a range satisfying an inequality**, and wherein **no additional microwave radiating antenna is located between the microwave radiating antenna and the dielectric body**, and wherein **one end of the standing wave is positioned on the plasma exciting surface**.

The Applicants submit that the applied prior art fails to teach or suggest all the elements of the presently claimed invention.

For reasons similar to those discussed above, the Applicants submit that the Tokuda, Ohmi, and Otsuda, taken either alone or in combination do not disclose or suggest a plasma processing method for processing an object using a plasma, the method comprising at least providing a dielectric body so as to be opposed to a microwave radiating surface, and determining **a distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, to be in a range satisfying an inequality**, and wherein no **additional microwave radiating antenna is located between the microwave radiating antenna and the dielectric body**, and wherein **one end of the standing wave is positioned on the plasma exciting surface**, as recited in claims 7, 8, 23, and 24.

As claims 7, 8, 23, and 24 are allowable, the Applicants submit that claims 9, 12-15, and 25-26, which depend from allowable claims 7, 8, 23, and 24, are therefore also allowable for at least this combination of reasons and for the additional subject matter recited therein.

C. The Examiner has Failed to Establish Prima Facie Obviousness

For at least the reasons set forth above, the Appellants submit that the applied art fails to disclose or suggest, either implicitly or explicitly, all of the elements of the presently claimed invention. Accordingly, the Appellants respectfully submit that the

Examiner has failed to set forth a *prima facie* case of obviousness with respect to claims 1-9, 12-14, and 16-26.

## IX. CONCLUSION

For all of the above-noted reasons, the Appellants respectfully submit that claims 1-9, 12-14, and 16-26 are not unpatentable under 35 U.S.C. § 103(a), and respectfully request the Honorable Board to reverse the rejection in this case and indicate the allowability of claims 1-9, 12-14, and 16-26.

In the event that this paper is not considered timely filed, the Appellants respectfully petition for an appropriate extension of time. Any fees for such extension, together with any additional fees which may be due with respect to this paper, may be charged to our Deposit Account No. 01-2300, making reference to attorney docket no. 107176-00007.

Respectfully submitted,

Sheree Rowe

Sheree Rowe
Registration Number 59,068

Customer Number 004372
ARENT FOX LLP
1050 Connecticut Avenue, NW, Suite 400
Washington, DC 20036-5339
Telephone: 202-857-6000
Fax: 202-857-6395

APPENDIX I: COPY OF THE CLAIMS ON APPEAL

1. (Previously Presented) A plasma processing apparatus for processing an object using a plasma, comprising:

a processing chamber defining a processing cavity for containing an object to be processed and a process gas therein;

a microwave radiating antenna having a microwave radiating surface for radiating a microwave in order to excite a plasma in the processing cavity; and

a dielectric body provided so as to be opposed to the microwave radiating surface;

wherein no additional microwave radiating antenna is placed between the microwave radiating antenna and the dielectric body;

wherein a distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, is determined to be in a range satisfying an inequality

$0.7 \times n/4 \leq D \leq 1.3 \times n/4$ (n being a natural number);

whereby a standing wave of the microwave is formed between the microwave radiating surface and a plasma exciting surface, thereby exciting a plasma at the plasma exciting surface by being supplied with energy from the standing wave of the microwave, the plasma exciting surface substantially coinciding with the surface of the dielectric body facing away from the microwave radiating surface, the plasma being formed between the plasma exciting surface and the object to be processed, the standing wave not entering the plasma,

wherein one end of the standing wave is positioned on the plasma exciting surface.

2. (Previously Presented) A plasma processing apparatus for processing an object using a plasma, comprising:

a process chamber defining a processing cavity for containing an object to be processed and a process gas therein;

a microwave radiating antenna having a microwave radiating surface for radiating a microwave in order to excite a plasma in the processing cavity; and

a dielectric body provided so as to be opposed to the microwave radiating surface;

wherein no additional microwave radiating antenna is located between the microwave radiating antenna and the dielectric body;

wherein a distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, is determined to be in a range satisfying an inequality

$0.7 \times n/2 \leq D \leq 1.3 \times n/2$ (n being a natural number);

whereby a standing wave of the microwave is formed between the microwave radiating surface and a plasma exciting surface, thereby exciting a plasma at the plasma exciting surface by being supplied with energy from the standing wave of the microwave, the plasma exciting surface substantially coinciding with the surface of the dielectric body facing away from the microwave radiating surface, the plasma being

formed between the plasma exciting surface and the object to be processed, the standing wave not entering the plasma,

wherein one end of the standing wave is positioned on the plasma exciting surface.

3. (Previously Presented) The plasma processing apparatus as claimed in claim 1, in which the dielectric body is a plate-shaped member disposed in such a manner that a distance between the dielectric plate and the plasma radiating surface is substantially zero, and a thickness d of the dielectric plate represented with the wavelength of the microwave being a distance unit is determined to be in a range satisfying an inequality

$0.7 \times n/4 \leq d \leq 1.3 \times n/4$ (n being a natural number).

4. (Previously Presented) The plasma processing apparatus as claimed in claim 2, in which the dielectric body is a plate-shaped member disposed in such a manner that a distance between the dielectric plate and the plasma radiating surface is substantially zero, and a thickness d of the dielectric plate represented with the wavelength of the microwave being a distance unit is determined to be in a range satisfying an inequality

$0.7 \times n/2 \leq d \leq 1.3 \times n/2$ (n being a natural number).

5. (Previously Presented) The plasma processing apparatus as claimed in claim 1, in which

the microwave radiating antenna is a radial line slot antenna having a number of slots formed and distributed in the microwave radiating surface thereof for radiating the microwave.

6. (Previously Presented) The plasma processing apparatus according to claim 1, wherein the microwave radiating antenna is a radial line slot antenna having a number of slots formed and distributed in the microwave radiating surface thereof for radiating the microwave, the number of the slots being concentrically arranged in the microwave radiating surface; and

wherein one per six or three slots in the peripheral direction of the slots arranged in the outermost peripheral part are closed so as to uniformize, in a plane, the plasma generated in the processing cavity.

7. (Previously Presented) A plasma processing method for processing an object using a plasma, the method comprising the steps of:

putting an object to be processed and a process gas into a processing cavity defined in a processing chamber;

radiating a microwave for exciting a plasma from a microwave radiating antenna having a microwave radiating surface to the processing cavity;

providing a dielectric body so as to be opposed to the microwave radiating surface; and

determining a distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating surface, which

is represented with a wavelength of the microwave being a distance unit, to be in a range satisfying an inequality

$0.7 \times n/4 \leq D \leq 1.3 \times n/4$ (n being a natural number),

whereby a standing wave of the microwave is formed between the microwave radiating surface and a plasma exciting surface, thereby exciting a plasma at the plasma exciting surface by being supplied with energy from the standing wave of the microwave, the plasma exciting surface substantially coinciding with the surface of the dielectric body facing away from the microwave radiating surface, the plasma being formed between the plasma exciting surface and the object to be processed, the standing wave not entering the plasma,

wherein one end of the standing wave is positioned on the plasma exciting surface, and

wherein no additional microwave radiating antenna is located between the microwave radiating antenna and the dielectric body.

8. (Previously Presented) A plasma processing method for processing an object using a plasma, the method comprising the steps of:

putting an object to be processed and a process gas into a processing cavity defined in a processing chamber;

radiating a microwave for exciting a plasma from a microwave radiating antenna having a microwave radiating surface to the processing cavity;

providing a dielectric body so as to be opposed to the microwave radiating surface; and

determining a distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, to be in a range satisfying an inequality

$0.7 \times n/2 \leq D \leq 1.3 \times n/2$ (n being a natural number),

whereby a standing wave of the microwave is formed between the microwave radiating surface and a plasma exciting surface, thereby exciting a plasma at the plasma exciting surface by being supplied with energy from the standing wave of the microwave, the plasma exciting surface substantially coinciding with the surface of the dielectric body facing away from the microwave radiating surface, the plasma being formed between the plasma exciting surface and the object to be processed, the standing wave not entering the plasma,

wherein one end of the standing wave is positioned on the plasma exciting surface, and

wherein no additional microwave radiating antenna is located between the microwave radiating antenna and the dielectric body.

9. (Previously Presented) The plasma processing apparatus as claimed in claim 5, in which

a part of the number of slots is closed so as to uniformize, in a plane, the plasma generated in the processing cavity.

10-11. (Cancelled)

12. (Previously Presented) The plasma processing method as claimed in claim 7, in which

the microwave radiating antenna is a radial line slot antenna having a number of slots formed and distributed in the microwave radiating surface thereof for radiating the micro

13. (Previously Presented) The plasma processing method as claimed in claim 12, further comprising:

a step of closing a part of the number of slots so as to uniformize, in a plane, the plasma generated in the processing cavity.

14. (Previously Presented) The plasma processing method as claimed in claim 13, wherein the number of the slots are concentrically arranged in the microwave radiating surface; and

wherein the step of closing the slots includes the step of closing one per six or three slots in the peripheral direction of the slots arranged in the outermost peripheral part.

15. (Cancelled)

16. (Previously Presented) A plasma processing apparatus for processing an object using a plasma, comprising:

a processing chamber defining a processing cavity for containing an object to be processed and a process gas therein;

a microwave radiating antenna having a microwave radiating surface for radiating a microwave in order to excite a plasma in the processing cavity, the microwave radiating antenna being a radial line slot antenna having a number of slots formed and distributed in the microwave radiating surface; and

a dielectric body provided so as to be opposed to the microwave radiating surface,

wherein no additional microwave radiating antenna is located between the microwave radiating antenna and the dielectric body;

wherein a distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, is determined to be in a range satisfying an inequality

$0.7 \times n/4 \leq D \leq 1.3 \times n/4$ (n being a natural number),

wherein one end of the standing wave is positioned on the plasma exciting surface.

17. (Previously Presented) A plasma processing apparatus for processing an object using a plasma, comprising:

a processing chamber defining a processing cavity for containing an object to be processed and a process gas therein;

a microwave radiating antenna having a microwave radiating surface for radiating a microwave in order to excite a plasma in the processing cavity, the microwave radiating antenna being a radial line slot antenna having a number of slots formed and distributed in the microwave radiating surface; and

a dielectric body provided so as to be opposed to the microwave radiating surface,

wherein no additional microwave radiating antenna is located between the microwave radiating antenna and the dielectric body;

wherein a distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, is determined to be in a range satisfying an inequality

$0.7 \times n/2 \leq D \leq 1.3 \times n/2$ (n being a natural number),

wherein one end of the standing wave is positioned on the plasma exciting surface.

18. (Previously Presented) The plasma processing apparatus as claimed in claim 16, in which the dielectric body is a plate-shaped member disposed in such a manner that a distance between the dielectric plate and the plasma radiating surface is substantially zero, and a thickness d of the dielectric plate represented with the wavelength of the microwave being a distance unit is determined to be in a range satisfying an inequality

$0.7 \times n/4 \leq d \leq 1.3 \times n/4$ (n being a natural number).

19. (Previously Presented) The plasma processing apparatus as claimed in claim 17, in which the dielectric body is a plate-shaped member disposed in such a manner that a distance between the dielectric plate and the plasma radiating surface is substantially zero, and a thickness d of the dielectric plate represented with the wavelength of the microwave being a distance unit is determined to be in a range satisfying an inequality

$0.7 \times n/2 \leq d \leq 1.3 \times n/2$ (n being a natural number).

20. (Previously Presented) The plasma processing apparatus according to claim 16, in which a part of the number of slots is closed so as to unifomize, in a plane, the plasma generated in the processing cavity.

21. (Previously Presented) The plasma processing apparatus according to claim 16, in which the number of the slots are concentrically arranged in the microwave radiating surface.

22. (Previously Presented) The plasma processing apparatus according to claim 21, wherein one per six or three slots in the peripheral direction of the slots arranged in the outermost peripheral part are closed so as to uniformize, in a plane, the plasma generated in the processing cavity.

23. (Previously Presented) A plasma processing method for processing an object using a plasma, the method comprising the steps of:

putting an object to be processed and a process gas into a processing cavity defined in a processing chamber;

radiating a microwave for exciting a plasma from a microwave radiating antenna having a microwave radiating surface to the processing cavity, the microwave radiating antenna being a radial line slot antenna having a number of slots formed and distributed in the microwave radiating surface;

providing a dielectric body so as to be opposed to the microwave radiating surface; and

determining a distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, to be in a range satisfying an inequality

$0.7 \times n/4 \leq D \leq 1.3 \times n/4$ (n being a natural number),

wherein one end of the standing wave is positioned on the plasma exciting surface, and

wherein no additional microwave radiating antenna is placed between the microwave radiating antenna and the dielectric body.

24. (Previously Presented) A plasma processing method for processing an object using a plasma, comprising the steps of:

putting an object to be processed and a process gas into a processing cavity defined in a processing chamber;

radiating a microwave for exciting a plasma from a microwave radiating antenna having a microwave radiating surface to the processing cavity, the microwave radiating antenna being a radial line slot antenna having a number of slots formed and distributed in the microwave radiating surface;

providing a dielectric body so as to be opposed to the microwave radiating surface; and

determining a distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, to be in a range satisfying an inequality

$0.7 \times n/2 \leq D \leq 1.3 \times n/2$ (n being a natural number),

wherein one end of the standing wave is positioned on the plasma exciting surface, and

wherein no additional microwave radiating antenna is placed between the microwave radiating antenna and the dielectric body.

25. (Previously Presented) The plasma processing method as claimed in claim 23, further comprising:

a step of closing a part of the number of slots so as to uniformize, in a plane, the plasma generated in the processing cavity.

26. (Previously Presented) The plasma processing method as claimed in claim 25, wherein the number of the slots are concentrically arranged in the microwave radiating surface; and

wherein the step of closing the slots includes the step of closing one per six or three slots in the peripheral direction of the slots arranged in the outermost peripheral part.

# APPENDIX II: EVIDENCE

There are no additional affidavits or evidentiary exhibits enclosed.

## APPENDIX III: RELATED PROCEEDINGS

There are no related appeals or interferences known to the Applicants or Appellants' representative which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.